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PROCEEDINGS
OF
THE ROYAL SOCIETY.

1836.

No. 28.

December 8, 1836.

FRANCIS BAILY, Esq., V.P. and Treas., in the Chair.

Charles Mackenzie, Esq., who at the last Anniversary had ceased to be a Fellow from the non-payment of his annual contribution, was, at this meeting, re-admitted by ballot into the Society, agreeably to the provision of the Statutes.

A paper was read, entitled, "Inquiries respecting the Constitution of Salts. Of Oxalates, Nitrates, Phosphates, Sulphates, and Chlorides." By Thomas Graham, Esq., F.R.S. Edin., Professor of Chemistry in the Andersonian University of Glasgow, Corresponding Member of the Royal Academy of Sciences of Berlin, &c. Communicated by Richard Phillips, Esq., F.R.S.

The results which the author had obtained from his former experiments, and of which he communicated an account to the Royal Society, suggested to him the probability that the law with respect to water being a constituent of sulphates, would extend also to any hydrated acid and the magnesian salt of that acid. As he had already found that the sulphate of water is constituted like the sulphate of magnesia, so he now finds the oxalate of water to resemble the oxalate of magnesia, and the nitrate of water to resemble the nitrate of magnesia. His researches render it probable that the correspondence between water and the magnesian class of oxides extends beyond their character as bases; and that in certain subsalts of the magnesian class of oxides, the metallic oxide replaces the water of crystallization of the neutral salt, and discharges a function which was thought peculiar to water. In the formation of a double sulphate, the author finds that a certain degree of substitution or displacement occurs; such as the displacement of an atom of water pertaining to the sulphate of magnesia, by an atom of sulphate of potash, to form the double sulphate of magnesia and potash. The same kind of displacement appears to occur, likewise, in the construction of double oxalates; and the application of this principle enables us to understand the constitution both of the double and super-oxalates, and to explain the mode of their derivation.

The author then proceeds to apply these principles to the analysis of the oxalates; and 1st, of the oxalate of water, or hydrated oxalic acid; 2ndly, of oxalate of zinc; 3rdly, of oxalate of magnesia; 4thly, of oxalate of lime; 5thly, of oxalate of barytes; 6thly, of oxalate of potash; 7thly, of binoxalate of potash; 8thly, of quadroxalate of potash; 9thly, of oxalate of ammonia; 10thly, of oxalate of soda; 11thly, of binoxalate of soda; and lastly, of the double oxalates, such as, 1st, oxalate of potash and copper; 2ndly, oxalate of chromium and potash; 3rdly, oxalate of peroxide of iron and potash; and 4thly, of oxalate of peroxide of iron and soda.

In the second section he treats of the nitrates; and 1st, of hydrated nitric acid, or the nitrate of water; 2ndly, of nitrate of copper; 3rdly, of subnitrate of copper; 4thly, of nitrate and subnitrate of bismuth; 5thly, of nitrate of zinc; 6thly, of nitrate of magnesia; and 7thly, of supposed double nitrates and supernitrates. He concludes, from his experiments on this subject, that there is no proof of the existence of a single supernitrate.

In the third section he discusses the constitution of the phosphates. Phosphoric acid, he observes, is quite peculiar in being capable of combining with bases in three different proportions; forming, besides the usual class of monobasic salts, containing one atom of acid to one atom of protoxide as base, two other anomalous classes of salts, in which two or three atoms of base are united to one atom of acid, namely, the pyrophosphates and the common phosphates, as they are usually denominated, but which the author proposes to designate by the terms, *bibasic*, and *tribasic* phosphates. Arsenic acid forms only one class of salts; but that class is anomalous; every member of it containing three atoms of base to one atom of acid, like the common, or tribasic, phosphates. These anomalous classes of phosphates and arseniates, with, perhaps, the phosphites, are, the author believes, the only known salts to which the ordinary idea of a subsalt is truly applicable: all other reputed subsalts being probably neutral in composition, as has been shown by the author in the case of the subnitrate of copper; for they all bear an analogy to this salt in their small solubility and other properties, while they exhibit little resemblance to those classes of phosphates and arseniates which really possess more than one atom of base. A table is then given, containing the formulæ expressing the composition of the most important phosphates, together with a new nomenclature by which, in accordance with his views, the author proposes to designate these salts. He then enters into the details of experiments illustrating the composition of, 1st, tribasic phosphate of soda, ammonia, and water, (or the microcosmic salt of the old chemists); 2ndly, tribasic phosphate of zinc and water, (or what is commonly called phosphate of zinc); 3rdly, tribasic arseniate of magnesia and water, (the common arseniate of magnesia); 4thly, tribasic phosphate of magnesia and water, (or ordinary phosphate of magnesia); and 5thly, tribasic phosphate of magnesia and ammonia, (or ammoniaco-magnesian phosphate).

In the fourth section he treats of sulphates, and supports, by fur-

ther evidence, the opinion he formerly advanced; that as bisulphate of potash is a double sulphate of water and potash, and therefore neutral in its composition, so, with the sole exception of the anomalous class already noticed, all salts, usually considered as bisalts are, in like manner, really neutral in composition. He shows that this theory is strictly applicable to the red chromate of potash, which appeared to present a difficulty.

The chlorides are next considered. The law followed by the chlorides of the magnesian class of metals appears to be that they have two atoms of water strongly attached to them, and which may, therefore, be regarded as constitutional. Thus, chloride of copper crystallizes with two atoms of water, and with no lower proportion; but several chlorides of this class have two or four atoms more; the proportion of water advancing by multiples of two atoms. The chlorides have probably their analogues in the cyanides, although we are less acquainted with the single cyanides of iron, copper, &c.: but the disposition of the protocyanide of iron, and of the cyanide of copper to combine with two atoms of cyanide of potassium, may depend on the cyanides of iron and of copper possessing, like the corresponding chlorides, two atoms of constitutional water, which are displaced by two atoms of the alkaline cyanide in the formation of the double cyanides.

December 15, 1836.

WILLIAM LAWRENCE, Esq., V.P., in the Chair.

Thomas Graham, Esq., M.A., was elected a Fellow of the Society.

A paper was read, entitled, "Further Observations on the Optical Phenomena of Crystals." By Henry Fox Talbot, Esq., F.R.S.

The author had described, in a former paper, the remarkable circular mode of crystallization frequently occurring from a solution of borax in phosphoric acid, and producing, when examined by the polarising microscope, the appearance of a black cross, with four sectors of light, and occasionally coloured rings, upon each crystal. In the present memoir, he describes some deviations from the usual forms of crystalline circles; the most striking varieties consisting in the cross being itself highly coloured, instead of black, upon a white ground. The author shows that these crystals consist of boric acid alone, resulting from the decomposition of the borax by the phosphoric acid. He gives an explanation of the optical appearances they present on the hypothesis of their being constituted by an aggregate of acicular crystals, radiating from a central point; and the whole circle being of variable thickness at different distances from its centre, and acting with great energy on polarised light. Other modes of crystalline formation, dependent chiefly on the pre-